

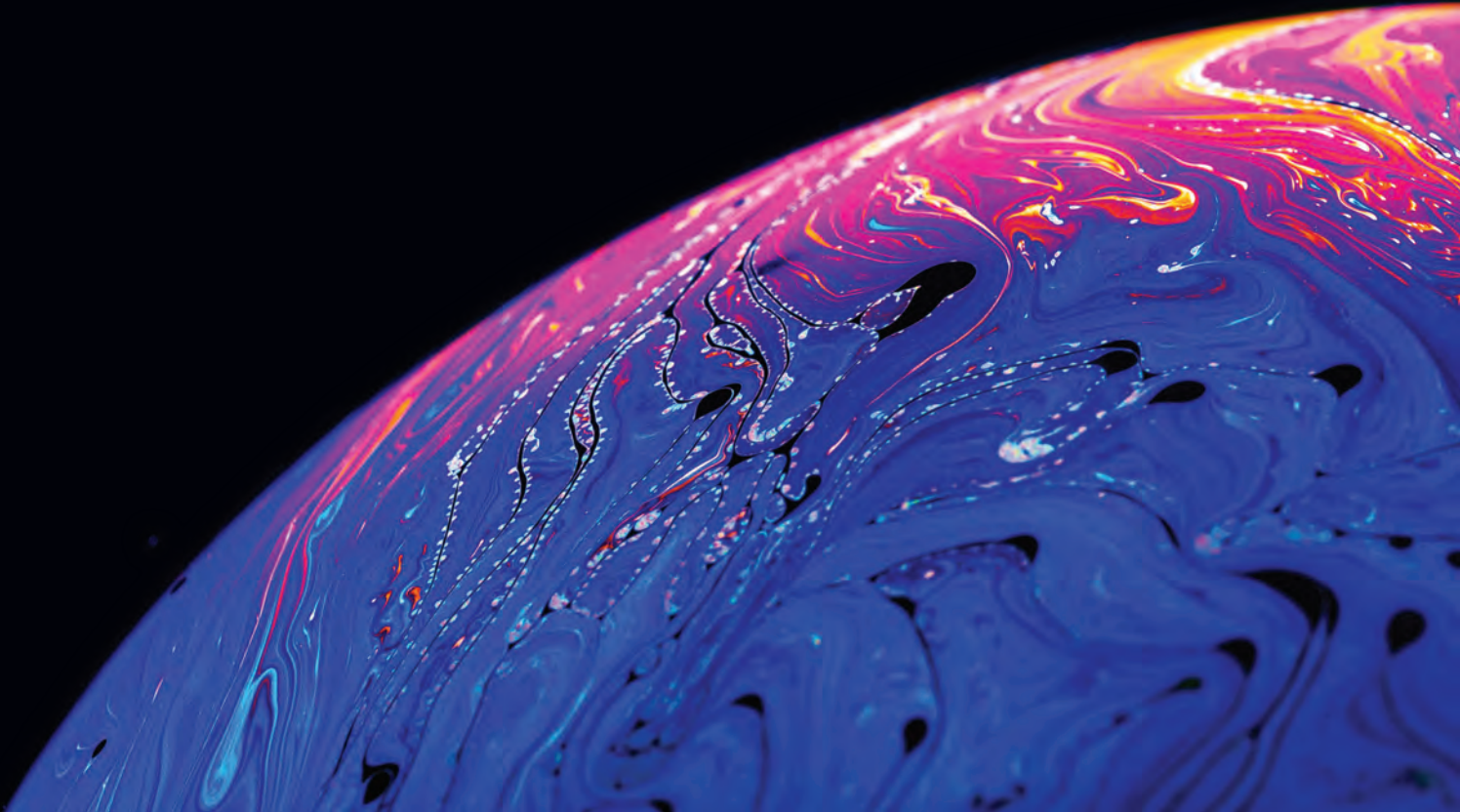


CARNEGIE
SCIENCE

Annual Report

2020

Fiscal Year July 2019 - June 2020





CARNEGIE SCIENCE

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This is a selection of materials from our
annual report, which can be found in full at:
www.carnegiescience.edu/annual-report/2020.

A Message from Our President

For more than a century, the Carnegie Institution for Science has pursued our mission of discovery, seeking to expand humanity's understanding of the natural world and the universe. We seek out and support brilliant researchers who approach their work with exceptional boldness, independence, and insatiable curiosity, and we provide them with the tools and flexibility required to ask—and to answer—some of the biggest and most significant scientific questions of our age.



COURTESY DAMIEN JEMISON

Eric D. Isaacs

Today, the nature of science is changing around us. Increasingly, forefront science requires both individual researchers and diverse teams who use world-class equipment and facilities and work across disciplinary boundaries to expand our understanding of matter, life, Earth, and the universe. To remain at the vanguard of discovery, the Carnegie Institution for Science is evolving with the scientific enterprise and taking thoughtful, deliberate steps to strengthen our structure, extend our influence, expand our expertise, and ensure our institutional health and independence in the years to come. By implementing a new, comprehensive plan for the future of Carnegie Science, we are ensuring our ability to continue and strengthen our world-leading research.

Our first step has been to bring our scientists together under three new divisions, focused on astronomy and astrophysics, Earth and planetary science, and life and environmental science. These divisions will be consolidated in two U.S. locations, in our current research campus in Washington, D.C., and in a new, expanded footprint in Pasadena, CA, that will include a new building designed to meet the research needs of our life scientists. This organization will support and encourage new research ventures that cross disciplinary lines, reduce internal barriers to collaboration, and create opportunities for Carnegie researchers to explore and discover.

Our plans for Pasadena include a deeper, more formal relationship with Caltech that will build upon our historic collaborations in astronomy and

astrophysics and offer exciting new opportunities in global ecology, genetics and developmental biology, and plant biology. The Pasadena location also will enable us to expand upon existing Carnegie research relationships with Jet Propulsion Laboratory and other universities and institutions in and around Los Angeles. Looking ahead, we believe Carnegie will make a powerful contribution to Southern California's growing reputation as a top-tier research hub.

To support our plans for our new location and to secure our ability to invest in future science, we have decided to sell our P Street headquarters, following a discernment process that has taken place over several years. We are aware that this beautiful building has been an important part of this institution's public face for more than a century, and it has provided some exceptional opportunities to bring our science to the public, and to convene communities of scientists. Unfortunately, it is not well suited for scientific exploration in the 21st century. So we have come to the realization that it is time to sell this great asset and invest the proceeds in our work and our future.

I would add that the last year has given us additional insights into the best ways to engage with the public. The pandemic forced us to make our evening lecture series virtual instead of presenting in our P Street auditorium. Although we were initially hesitant about making that shift, we have found that our virtual lectures are drawing an audience of science-loving people from around the world. That proved to us that people are interested what we have to say, not where we say it.

Throughout these organizational changes, our science has continued to flourish. Astronomer Andrew McWilliam and his collaborators have been turning their gaze from the chemical evolution of Red Giant stars to take a deeper look at the atmospheres of terrestrial exoplanets. Their colleague at the Observatories, staff scientist Nick Konidaris, is serving as instrument lead for the Sloan Digital Sky Survey-V's Local Volume Mapper, a coordinated system of four telescopes that will enable a massive spectrographic survey that will reveal for the first time how distinct gaseous environments within galaxies interact with each other and with stars.

Geoscientists Steven Shirey, Anat Shahar, and Michael Walter have won a National Science Foundation grant to study the minerals trapped in "superdeep" diamonds that form in the Earth's mantle. These minerals provide important insights into the origins, changing composition, and circulation of materials hundreds of miles below Earth's surface. In Life

Sciences, Moises Exposito-Alonso and his team are improving our ability to predict species extinction by investigating the ways the ability to adapt is encoded in DNA. Given recent predictions that one-third of all animal and plant species on the planet could face extinction by 2070 due to climate change, the ability to develop predictive models of ecological adaptation could be crucially important.

We also continue our commitment to science education and outreach. As you'll read in this report, our Carnegie Academy for Science Education (CASE) has opened the doors to careers in biotech for high school students by partnering with the National Capitol Area YWCA to create a rigorous biotechnology curriculum, including research-grade laboratory equipment, for teachers in Washington, DC.

One sad note: We continue to feel the loss of Don Brooks, our Building Maintenance Specialist. He died in October at age 75 of complications of coronavirus after more than half a century as a member of the Carnegie Science community.

Throughout this difficult year, I have gained strength and encouragement from the example set by so many of our dedicated colleagues. I believe that the lessons we have learned together throughout this pandemic will guide us as we work to renew our organization, strengthen our leadership, and expand our impact.

We stand at a pivotal moment in the history of Carnegie Science. This organization has endured and flourished for more than a century because our founder understood the powerful results that can be achieved when great scientists have the freedom and resources to follow their curiosity, pursue novel ideas, and tackle the big questions that capture their imagination and inspire their best work. As we move forward, our every effort will be focused on assuring Carnegie Science's present and future ability to pursue bold research, seize new opportunities as they arise, and define new exciting fields of investigation from their very inception.

Sincerely,

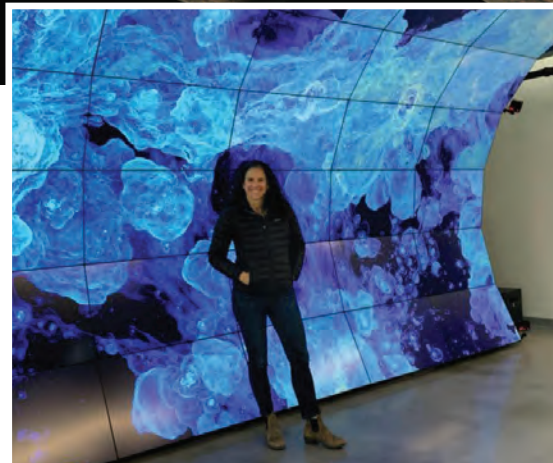
A handwritten signature in black ink, appearing to read "Eric D. Isaacs". The signature is fluid and cursive, with the first name "Eric" and last name "Isaacs" clearly distinguishable.

Eric D. Isaacs

VizLab: Virtual Reality Tours the Cosmos

Carnegie astronomers are wrestling with a data tsunami from both our observable universe and from the advanced numerical models that enable us to understand modern observations. The next generation of these calculations and surveys, such as the all-sky Sloan Digital Sky Survey-V led by Juna Kollmeier, Founding Director of the Carnegie Theoretical Astrophysics Center, requires new methods and tools for interrogating the universe and comparing it with our theoretical understanding. Enter VizLab, where real and simulated data can be analyzed with 21st-century, multidimensional representations using modern virtual reality tools.

Simulated and observed data are needed in tandem to test astronomical and cosmological predictions. Astronomy's capacity to record increasing amounts of information from more numerous objects in the universe, combined with the ability to numerically simulate the evolution of the universe, is a natural consequence of advances in computing ability. Carnegie astronomers have pioneered advanced astronomical telescopes and



CTAC Founding Director Juna Kollmeier in the Carnegie Observatories VizLab with an IllustrisTNG project image on the wall.

VizLab, where real and simulated data can be analyzed with 21st-century, multidimensional representations using modern virtual reality tools.

instrumentation for over 100 years. The VizLab is a natural outgrowth of this tradition.

VizLab was recently constructed in a garage at the Observatories in Pasadena, California, and will become a space where scientists can probe their simulated and observed data to answer the most pressing scientific questions of the day, such as examining the energetic forces of black holes in galaxy centers, studying the highest energy particles in the universe, developing techniques to understand the mysteries of “dark matter” and “dark energy,” unraveling the mechanisms of supernovae explosions, refining the expansion rate of the universe, and much more.

In addition to these scientific pursuits, the VizLab will help to educate the next generation of Carnegie scientists. The Observatories has a long history of engaging students and the public about the vast universe that surrounds them. Learners from the youngest to the oldest will be able to take virtual tours of Carnegie telescopes at its Las Campanas Observatory in Chile, walking through the control room, onto the observing floor, and even up the telescope sides, as examples. VizLab passed its site acceptance test at the end of September 2020, and will open safely to visitors later in 2021.

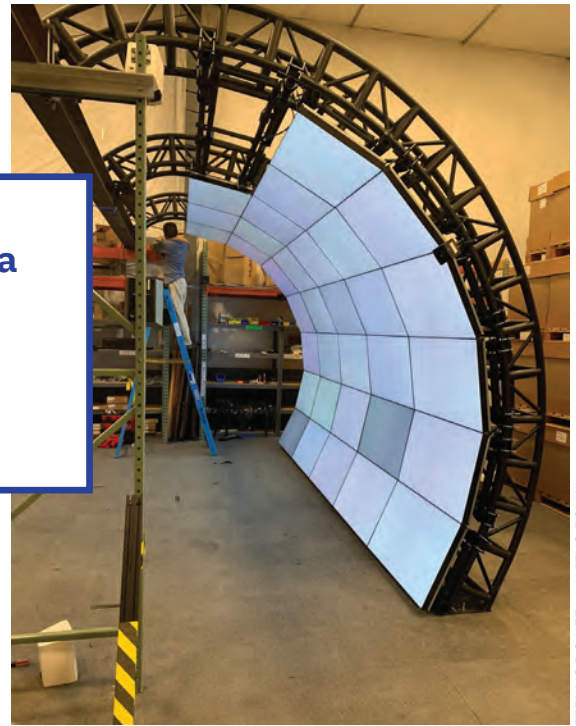


IMAGE CREDIT TYLER O'DONNELL

The VizLab under construction by the Mechdyne Corporation.

Earth

Surprise About Earth's Protective Magnetic Field

Life on Earth's surface cannot exist without our magnetic field. It deflects dangerous ionizing particles from solar wind and cosmic rays. The convective motion of liquid iron in Earth's outer core, called a geodynamo, generates this field. But new research from a team,

They found that the geodynamo could have functioned on heat transmission alone for the planet's entire history.

including current and former Carnegie scientists, examined how lighter elements in the mostly iron core could affect the geodynamo's origin and sustainability. Surprisingly, they found that the outward flow of heat from the core, when iron is alloyed with silicon, is sufficient to sustain the geodynamo through thermal convection alone.

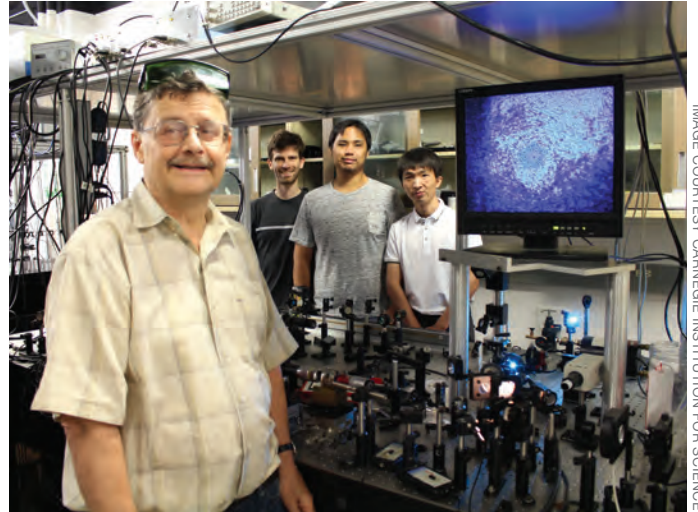
Thermal conduction and convection in the core are the two major heat transfer mechanisms. The thermal conductivity of the alloy of iron and other elements in the core is necessary to reconstruct the thermal and geodynamo history of the core, but it had not been directly measured at the high pressure and temperature conditions found there until this study.

The core is predominantly iron, but seismic data indicates that lighter elements like oxygen, silicon, sulfur, carbon, and hydrogen were dissolved into it during the differentiation process, which created Earth's layered structure of crust, mantle, and core. Silicon is the third most abundant element in the Earth. The researchers studied a silicon-iron alloy because of its geophysical and geochemical characteristics.

The research team was led by Wen-Pin Hsieh of Academia Sinica and National Taiwan University, with current and former Carnegie scientists Alexander Goncharov, Nicholas Holtgrewe, Sergey Lobanov, and Irina Chuvashova. They subjected solid iron and different alloys of iron and silicon, to core conditions, up to 1.4 million times atmospheric pressure (144 GPa) and temperatures up to 5500°F (3300 K).

They found that the geodynamo could have functioned on heat transmission alone for the planet's entire history with a core concentration of about 8 weight percent silicon alloyed with iron. The research community has had a broad range of possible ages for the inner core from 0.5 to 2 billion years old. But this result suggests that the age of Earth's inner core could be much older.

Carnegie's Peter Driscoll, who models the dynamo, theoretical physicist Ron Cohen, and Goncharov recently joined efforts in addressing this issue. They plan to perform more experiments and theoretical calculations on materials with different compositions and refine their dynamo models.



Alex Goncharov is shown (foreground) in his lab with some of his colleagues.

IMAGE COURTESY CARNEGIE INSTITUTION FOR SCIENCE

A First: Connecting Genomics and Ecological Modeling

Human-induced climate change and exploitation increased species' extinction rate over 1,000-fold in the 20th century—50 percent suffered local extinctions. However, researchers have not been able to predict which species can and cannot adapt. Until now, ecological adaptation models have not included genomic information. Carnegie's Moises Exposito-Alonso's team investigated how adaptation is molecularly encoded in DNA and developed predictive models of future extinction risk.

This method has roots in the legendary 1941 experiments of Carnegie's Jens Clausen, David Keck, and William Hiesey, who planted seeds of common species of different California plant populations. When they planted seeds of the same species in environments close to seed collection points, they grew best, indicating they genetically adapted despite looking almost identical. Without today's technology, the team could not pinpoint specific adaptive mutations. Exposito-Alonso and colleagues used this concept to understand species' susceptibility to changing climate conditions

...they developed the first ecological risk model of population maladaptation under climate change that accounts for genome-wide mutations...

using the model plant, *Arabidopsis thaliana*, which grows naturally in different climates around the world.

They conducted experiments—similar to those of Clausen, Keck, and Hiesey—in Germany and Spain, simulating expected precipitation changes in Europe. They planted about half a million seeds from 500 European locations and studied their growth and survival. They found specific genetic differences in the plants' DNA. Remarkably, similarly looking plants, grown in the same soil with the same water, had different outcomes: some shriveled and died, while others remained green and flowered. The team developed algorithms to sort through 10 million DNA changes and identified several thousand that best explained the differences.

With these results, they developed the first ecological risk model of population maladaptation under climate change that accounts for genome-wide mutations of each natural population. The prediction map showed how lower precipitation trends in Europe will decrease adaptation and increase risk of local extinction of Central European populations, which have not experienced past droughts. These populations differ from Mediterranean *Arabidopsis*, which have mutations that could increase survival under future heat and drought conditions.

The team now wants to test these climate adaptation models with a globally distributed experiment and a consortium network called Genomics of rapid Evolution in Novel Environments (GrENE-net). In the long run, these models will be applied to keystone ecosystem species to understand climate-change resilience.



MOISES EXPOSITO-ALONSO, CARNEGIE INSTITUTION FOR SCIENCE

The Exposito-Alonso team looked for genetic variants using rainfall reduction experiments in Spain and Germany. They used 500 genetically distinct native *Arabidopsis* plants from all over Europe and simulated rapid drought changes. They then looked for genetic differences in survival. Remarkably, similarly looking plants, grown in the same soil with the same water, had different outcomes: some shriveled and died (mid left and bottom right), while others remained green and flowered (mid right and bottom left)

Donor Stories

For the full FY20 donor recognition list please visit www.carnegiescience.edu/annual-report/2020.



Nathalie Valette-Silver

In 1978, I came to America from France for a postdoctoral fellowship position in geochemistry. It wasn't too long after I arrived that I attended the American Geophysical Union conference, where



Dr. Nathalie Valette-Silver
and Dr. Paul G. Silver

I met Paul through a friend. Though it was some time until we met again, we kept in touch—and in 1980 we were married.

Paul became a staff member at Carnegie Science in the

Department of Terrestrial Magnetism (now the Earth and Planets Laboratory) in 1982. After a year at Johns Hopkins University, I came to Carnegie as a postdoctoral fellow. The time we spent working at Carnegie together was among the happiest of our scientific years. Later on, our daughter, Celine also came to Carnegie for a summer internship

and loved it—Carnegie holds a special place in our family.

The culture of Carnegie was unlike any I had experienced elsewhere in the United States—it reminded me of my time in France as a researcher. At Carnegie you are free to focus on the science and your research. Discussing important discoveries with colleagues in various disciplines broadens your scientific knowledge and can make all the difference.

We both flourished at Carnegie. We were free to think and to invent, and for Paul this was especially important because he was a very creative person. I established the Dr. Paul G. Silver Postdoctoral Fellowship to give others the same opportunities Paul and I were fortunate enough to have at Carnegie Science.

It is more important now, maybe than at any other time, that we support the institutions, places, and people who are dedicated to getting the facts and the science right. I believe strongly that Carnegie is one of these places. I want to support its continued spirit of freedom in scientific pursuits and its place at the vanguard of discovery.

Charles & Virginia Peterson

If one is lucky enough in life, we have the opportunity to meet someone who has a profound positive impact on our lives. For me, that person was Vera Rubin. I spent two years with her at the Carnegie Science Department of Terrestrial Magnetism (now the Earth and Planets Laboratory) as a postdoctoral fellow in astronomy.

I will never forget her strength and the dedication to science Vera displayed day in and day out among a predominantly male team. She was not interested in recognition or awards, she simply wanted to do science because she loved it. Her work ethic has stayed with me throughout my own career.

Vera wrote me a letter of recommendation at the end of my fellowship with Carnegie that helped me to secure my next fellowship, and in-turn led to a successful career in academia. My time at Carnegie was unlike anywhere else I worked. The camaraderie and level of intellectual excellence of my fellow scientists was unparalleled—and I am grateful for the time I spent at this unique institution.

My wife, Virginia, and I have been fortunate that our investments have paid off—and now we want to be able to give back. To be able to help a young scientist, in a similar way Vera helped me, is a great honor. That's why Virginia and I have left a gift in our estate to Carnegie Science. All of humanity benefits from scientific exploration and we want to make sure the research continues forward at this important institution.



Virginia and Charles Peterson

Eric & Jill Hubbell



Eric and Jill Hubbell
with their son and
family dog

When it comes to your family and the future for your children, we all want to invest in the organizations and institutions that will help build the world we envision. For Eric and Jill Hubbell, new parents to a baby boy, this means supporting Carnegie Science and its work in the pursuit of a healthier, cleaner, and better world. The Hubbells made their first gift to Carnegie Science through Eric's family foundation in 2014.

Climate change is one of the more important issues to the Hubbells. With

average temperatures rising yearly and an increase in natural disasters, both Eric and Jill feel that, as responsible global citizens, we must focus our energy on understanding and solving this crisis. Eric said, "You can't solve a problem until you know what the data is saying and so scientific exploration must be our approach. We are seeing shorter life spans for humans because of the effects of climate change. How much more evidence do you need?"

Eric and Jill consider their giving to Carnegie Science as an investment. "When people think of giving to charity, they don't always think of funding science," Jill said, "but we are inspired to create change and Eric and I believe strongly that by giving to Carnegie Science we are helping to build a better future, not just for our son, but the generations that are to come."

Stuart Gerson & Pam Somers

Something of a scientist at heart, I was always drawn to the advances within the scientific and technological arenas. As a boy, I was inspired by giants like Einstein, von Neumann, and Feynman. And, though I didn't have abilities like theirs, I shared their enthusiasm for learning about the fundamental nature of the universe and the lifeforms that inhabit it.

Though I am a better lawyer than I would be a scientist, I am an inveterate questioner. It is the desire to understand that attracted me to the investigators at Carnegie Science, who are asking some of the biggest, most important, questions about our universe, how we came to be, and who we are.

My wife Pam and I discovered Carnegie by attending a book talk by Dr. Robert Hazen on the *Joy of Science*—and we have been captivated by the institution's work ever since. To have direct access to these incredible scientists at the lectures and events hosted by Carnegie has made a huge impact on Pam and me. Ultimately, we lead more complete and satisfying lives because of the knowledge we continue to gain through exposure to the research of Carnegie Science.



Pam Somers and Stuart Gerson

I understand acutely how individual funding helps in affording the flexibility and freedom that is essential for scientific research. It is the key to innovation. Compared to other countries, America is behind where we should be in science education and in providing enough opportunity in the sciences for diverse segments of our society. But, I believe Carnegie and the work of its researchers can help to get us there.



Neil Hurwitz

Neil Hurwitz

From a young age I had a great interest in and passion for science. The process of scientific discovery—asking questions, testing one’s hypotheses—was fascinating to me. In college I initially pursued a degree in astronomy, but I quickly discovered that a career in science was not going to be my journey.

Ultimately, I became a statistician within the corporate world. I enjoy the intellectual engagement of my job, but I wanted a way to stay connected to the scientific process I loved as a kid. That is when I discovered Carnegie Science. In 2017 I went to my

first lecture at the Carnegie Science building in Washington, DC. I was hooked on the breadth of discoveries and scientific research I could learn about at these public programs. I knew I found the way to bring the mysteries of discovery and scientific pursuit into my everyday life.

I feel most passionately about understanding our natural world, both here on Earth and in the larger cosmos. For our future generations, I want to help preserve a world where we pursue the unknown and strive to make our Earth a better place for all. When I sat down to draft my first will, I knew that leaving a legacy of scientific excellence and discovery was important to me, and that Carnegie could ensure my gift was used wisely and for the greatest impact. As someone who appreciates the importance of unbiased scientific research and wants the institutions that make that possible to keep thriving, I’m glad to be a part of Carnegie Science’s future.

The Gordon and Betty Moore Foundation

The Gordon and Betty Moore Foundation was established in 2000 to create positive outcomes for future generations. Like Carnegie, the Moore Foundation aims to advance basic scientific research and provides investigators with the freedom and flexibility to pursue new avenues of discovery. This year the Moore Foundation created its first cohort of 15 scientists to accelerate research in aquatic symbiosis as part of its new Symbiosis in Aquatic Systems Initiative.

Carnegie's Director of Embryology, Yixian Zheng, is among this group of dynamic awardees—a community of current and emerging leaders in aquatic symbiosis working to acquire new knowledge and advance the field. “The goal is to provide Yixian with the flexibility to explore new and risky ideas within aquatic symbiosis research—potentially leading to unanticipated new discoveries—but where that leads exactly is unknown and the most exciting part,” said program officer Sara Bender.

Zheng's research builds on Carnegie's longstanding tradition of model organism development and applies these tools and techniques to tackle a new challenge—elucidating the molecular mechanisms of coral symbiosis. She brings a unique perspective and expertise to this important work. The Gordon and Betty Moore Foundation fosters path-breaking scientific discovery, such as Zheng's, as well as environmental conservation, patient care improvements and preservation of the special character of the Bay Area. Carnegie Science is proud to partner with the Moore Foundation to drive innovation and support bold and transformational science.

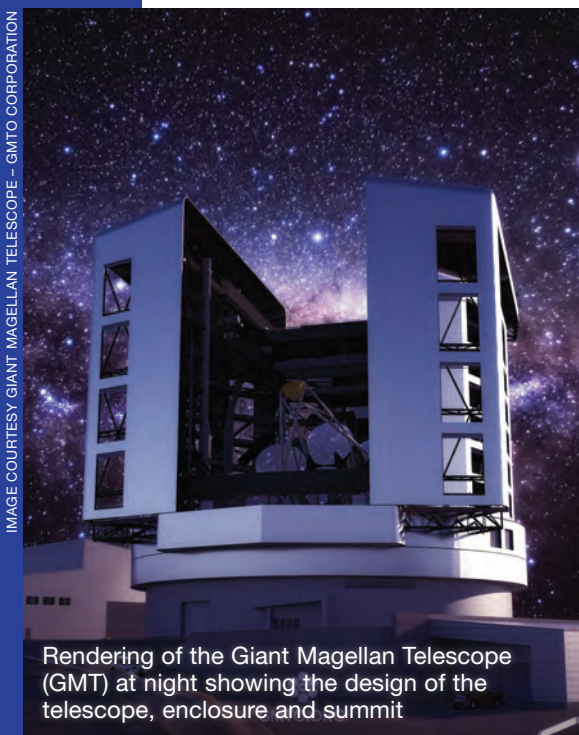


2018 EMB Xenia: Xenia coral

COURTESY CARNEGIE INSTITUTION FOR SCIENCE/ED HIRSCHMUGL

The Ambrose Monell Foundation

In 2019, the Ambrose Monell Foundation made a generous gift of \$1.25 million to support the Giant Magellan Telescope (GMT) Commissioning Camera (CommCam). CommCam will capture the first multi-color images taken with the GMT. The first telescope instrument of its kind, CommCam will be crucial in verifying the telescope's functionality in pointing, tracking, and maintaining focus over a large field of view across the sky. The Monell Foundation's longstanding investment in Carnegie's involvement in the GMT demonstrates its commitment to the potential of next-generation extremely large telescopes to make groundbreaking discoveries.



Rendering of the Giant Magellan Telescope (GMT) at night showing the design of the telescope, enclosure and summit

The Monell Foundation also supports the Carnegie Venture Grants program, which aims to break conventional boundaries by bringing together cross-disciplinary researchers to explore novel approaches to fundamental challenges and questions. Each grant provides up to \$150,000 in financial support. A recent venture grant is supporting the development of an instrument for detecting life-indicating molecules in exoplanet atmospheres. Another is funding a plan for using CRISPR/Cas9 gene editing to identify and test the genes that may control heat and bleaching tolerance in corals.

The Ambrose Monell Foundation has partnered with Carnegie Science since 1982 and supported many key research initiatives that have led to notable discoveries. The Foundation strives to have a longstanding

impact by supporting academic, scientific, environmental, and economic innovation. “The Foundation is proud of its continuing relationship with Carnegie” said Ambrose K. Monell, President of the Foundation. “In particular, we hope to advance Carnegie’s innovative and multidisciplinary approaches to expanding our understanding of the Earth and its history within our universe.”

Don Brooks

With more than a half-century

of employment under his belt, Carnegie Building Maintenance Specialist Don Brooks' career traced the path of the institution's modern administrative history. He died of complications related to the coronavirus in October 2020, just months shy of retirement. He was 75.

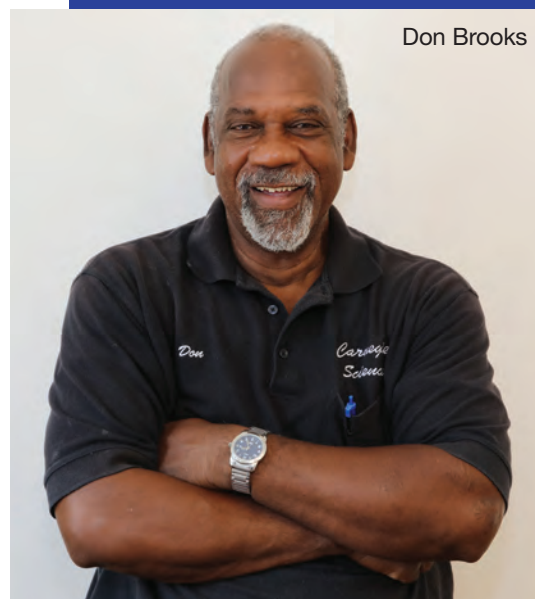
Brooks worked for Carnegie for 52 years, advancing through several positions over the course of seven presidential administrations at the institution, often interacting closely with leadership.

His first job was to help President Caryl Haskins to care for the ants and fish he housed in Carnegie's downtown Washington, DC administrative building.

"Oh yes, all those fish," said his wife, Gloria Brooks, laughing as she reminisced about how Brooks would meet Haskins at the airport when he was returning from a fieldwork trip, so that he could collect new fish samples and bring them straight to the office.

Brooks loved to engage a crowd of colleagues, but one person stands out as Don's most cherished relationship; he spoke often of his high esteem for President Emerita Maxine Singer, the National Medal of Science-winning molecular biologist.

"Don's work played a vital role in our ability to open Carnegie's doors to the DC community



ABBY SEVICK CARNEGIE INSTITUTION FOR SCIENCE

and welcome everyone in for our various programs," Singer said. "Not only was he an outstanding employee for more than half a century, he was also a devoted friend for many years."

In 1966, Brooks and his wife's cousin moved to the District from Natchez, Mississippi, where he grew up with eight siblings picking cotton and vegetables. His younger brother, Leroy Brooks, reminisced about how he, Don, and two of their brothers participated in Civil Rights marches and rallies in the area

"The entire Carnegie Community mourns Don's untimely passing. He will be remembered as a dedicated friend and colleague. I extend my deepest sympathies to his wife, Gloria, and their family," said Carnegie President Eric D. Isaacs.

Brooks was survived by his wife, four children, fourteen grandchildren, and ten great-grandchildren, as well as by two sisters and three brothers.

**EARTH AND PLANETS
LABORATORY**

**Richard Carlson
Receives Geochemical
Society's Highest Honor**

In January 2020, Richard Carlson, Director of Carnegie's Earth and Planets Laboratory, was chosen to receive the Geochemical Society's highest honor, the Victor Moritz Goldschmidt Award, in recognition of his forefront research into the formation of the Solar System and the geologic history of the Earth.

**Alycia Weinberger
Selected Inaugural American
Astronomical Society Fellow**

In February 2020, Carnegie astronomer Alycia Weinberger was selected for the inaugural class of Fellows of the American Astronomical Society (AAS) in recognition of her "extraordinary achievement and service" to the field.

**Mike Walter
Elected American
Geophysical Union Fellow**

Mike Walter, Deputy Director of the Earth and Planets Laboratory, was elected a 2019 Fellow of the American Geophysical Union in August 2019. The organization said in its announcement of the new class, "Their breadth of interests and the scope of their contributions are remarkable and often groundbreaking."

**Robert Hazen
Inducted into Russian
Academy of Sciences and
Elected a Fellow of the
American Geophysical Union**

In the spring of 2020, Carnegie mineralogist Robert Hazen was inducted as a foreign member of the Russian Academy of Sciences—that nation's highest scientific society, originally founded by Peter the Great. This is a rare honor for an American researcher. In August 2019, he was elected a 2019 Fellow of the American Geophysical Union. Fellows are recognized for visionary leadership and scientific excellence that has fundamentally advanced research in the Earth and space sciences.

**Scott Sheppard
Shares Farinella Prize**

In September 2019, Carnegie's Scott Sheppard and his long-time colleague Chad Trujillo of Northern Arizona University received the Europlanet Society's 2019 Paolo Farinella Prize for "outstanding collaborative work for the observational characterization of the Kuiper belt and the Neptune-Trojan population."

EMBRYOLOGY

**Steve Farber and BioEYES
Recognized for Excellence in
Science Education**

The American Society for Cell Biology (ASCB) recognized Carnegie's Steven Farber and the University of Pennsylvania's Jamie Shuda in July 2020 with its Bruce Alberts Award for Excellence in Science Education, which honors "innovative and sustained contributions" to the field.

Kamena Kostova

Awarded NIH Director's Early Independence Award

In October 2019, Carnegie biologist Kamena Kostova was selected for the National Institutes of Health Director's Early Independence Award; this award is designed to provide "exceptional junior scientists" with the opportunity to "skip traditional post-doctoral training and move immediately into independent research positions."

OBSERVATORIES

John Mulchaey's Outreach Honored with Humanitarian Award

In March 2020, John Mulchaey, Director and Crawford H. Greenewalt Chair of the Carnegie Observatories, was presented with a Humanitarian STAR Award by the honor's founding body—the Rotary Club of Sierra Madre—for "outstanding scientific and technological achievements with significant humanitarian benefit." The award acknowledged his long-standing efforts at promoting outreach events and activities to share astronomy with enthusiasts of all ages throughout the Los Angeles area.

Steve Shectman

Selected Inaugural American Astronomical Society Fellow

In February 2020, Carnegie astronomer Steven Shectman was selected for the inaugural class of Fellows of the American Astronomical Society (AAS) in recognition of his "extraordinary achievement and service" to the field.

Decker French Receives Prestigious Award for Early Career Astronomers

In July 2019, Carnegie's K. Decker French was recognized by the Astronomical Society of the Pacific with its Robert J. Trumpler Award, which is presented to a recent Ph.D. graduate "whose research is considered unusually important to astronomy." French was a Hubble Fellow at the Carnegie Observatories from 2017 to 2020 and is now an assistant professor at the University of Illinois at Urbana-Champaign.

PLANT BIOLOGY

Moises Exposito-Alonso Recognized for Early Career Excellence by American Society of Naturalists and Max Planck Society's Otto Hahn Medal, plus *Forbes* 30 Under 30 List

In February 2020, evolutionary geneticist Moises Exposito-Alonso was one of four recipients of the American Society of Naturalists' Jasper Loftus-Hills Young Investigator Award in recognition of "outstanding and promising work" by individuals who are within three years of completing their Ph.D. or in their final year of graduate school. In March, he was named a member of the 2020 class of *Forbes* 30 Under 30 Europe list in science and healthcare. In July, the Max Planck Society's Otto Hahn Medal also awarded him for early career excellence.

**To see the complete 2020 annual report,
please go online and visit
www.carnegiescience.edu/annual-report/2020.**

Financial Summary

for the year ending June 30, 2020

The complete audited financial statements are made available on the institution's website at www.carnegiescience.edu.

Each year the Carnegie Institution, through the Audit Committee of its Board of Trustees, engages an independent auditor to express an opinion about the financial statements and the financial position of the institution.

The Carnegie Institution for Science completed fiscal year 2020 in sound financial condition after generating a net return of 2.1% on the diversified investments within its endowment; maintaining a disciplined spending policy that balances today's needs with the long-term requirements of the institution and the interests of future scientists; and the continued support of organizations and individuals who recognize the value of basic science.

The primary source of support for the institution's activities continues to be its endowment. This reliance on institutional funding provides an important degree of independence in the research activities of the institution's scientists.

As of June 30, 2020, the endowment was valued at \$927 million. Over the period 1998–2020, average annual distributions from the endowment to the budget were 5.0%. Carnegie closely controls expenses to ensure the continuation of a healthy scientific enterprise.

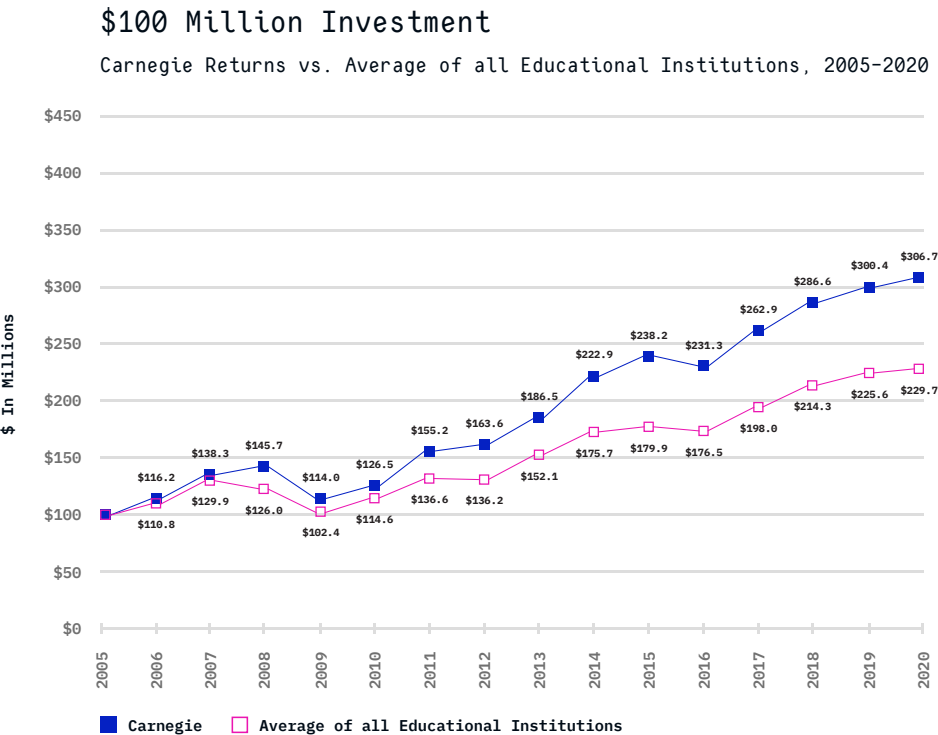
For several years, under the direction of the Investment Committee of the Board, Carnegie's endowment has been allocated among a broad spectrum of asset classes including: global equities, absolute return investments, real estate partnerships, private equity, venture capital, natural resources partnerships, and government bonds. The goal of this diversified approach is to generate attractive overall performance and reduce the volatility that would exist in a less diversified portfolio. In 2016 Carnegie hired its first Chief Investment Officer to more proactively steward the endowment's assets.

The Chief Investment Officer and Investment Committee regularly examine the asset allocation of the endowment and readjust the allocation, as appropriate. The institution relies upon external managers and partnerships to conduct the investment activities, and it employs a commercial bank to maintain custody.

ASSET CLASS	TARGET	ACTUAL
Common Stock	41.0%	39.1%
Alternative Assets	47.0%	53.1%
Fixed Income and Cash	12.0%	7.8%

This chart shows the allocation of the institution’s endowment among asset classes as of June 30, 2020.

Carnegie’s investment goals are to provide high levels of current support to the institution and to maintain the long-term spending power of its endowment. The success of Carnegie’s investment strategy is illustrated in the following figure that compares, for a hypothetical investment of \$100 million, Carnegie’s investment returns with the average returns for all educational institutions for the last fifteen years.



Carnegie has pursued a long-term policy of controlling its spending rate by using a hybrid spending rate, which in the long term contributes 5% of the endowment for annual use. Carnegie employs what is known as a 70/30 hybrid spending rule. That is, the amount available from the endowment in any year is made up of 70% of the previous year’s budget, adjusted for inflation, and 30% of the most recently completed

Statement of Financial Position

July 30, 2020 and 2019 (in thousands)

ASSETS	2020	2019
Cash and Cash Equivalents	\$ 30,125	\$ 33,050
Contributions Receivable	3,728	3,750
Accounts Receivable and other assets (net)	9,265	7,743
Bond Proceeds	120,582	21,661
Investments	917,741	953,113
Property and equipment (net)	118,276	126,641
Long term deferred asset	61,596	60,460
Total assets	\$ 1,261,313	\$ 1,206,418

LIABILITIES		
Accounts payable and accrued expenses	11,403	12,069
Deferred revenue	28,587	26,828
Bonds payable	214,348	115,032
Accrued Postretirement benefits	32,741	27,721
Total liabilities	287,079	181,650

NET ASSETS		
Without donor restriction	295,115	311,622
With donor restriction	679,119	713,146
Total net assets	974,234	1,024,768

Total liabilities and net assets	\$ 1,261,313	\$ 1,206,418
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To see the complete 2020 annual report,
please go online and visit
www.carnegiescience.edu/annual-report/2020.

Statement of Activities

July 30, 2020 and 2019 (in thousands)

REVENUE AND SUPPORT	2020	2019
Grants and contracts	\$ 17,668	\$ 20,526
Contributions, gifts	4,493	7,987
Other Income	2,358	7,559
Net external Revenue	24,519	36,072

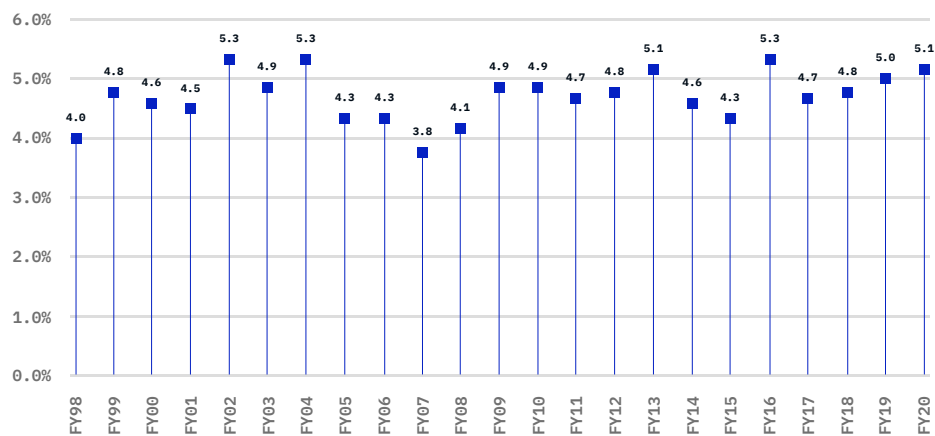
Investment income and unrealized gains	17,816	31,221
Total Revenue	\$ 42,335	\$ 67,293

EXPENSES		
Program and Supporting Services:		
Terrestrial Magnetism	10,274	10,039
Observatories	24,078	23,055
Geophysical Laboratory	11,809	13,294
Embryology	13,471	14,697
Plant Biology	9,173	9,360
Global Ecology	4,792	7,123
Other Programs	278	1,013
Administration and general expenses	14,416	14,968
Total Expenses	\$ 88,291	\$ 93,549

NET ASSETS		
Change in net assets before pension related changes	(45,956)	(25,378)
Pension related changes	(3,649)	(2,611)
Other components of postretirement benefit expense	(929)	(878)
Grant modifications	–	(5,188)
Net Assets at the beginning of the period	1,024,768	1,058,823

Net assets at the end of the period	\$ 974,234	\$ 1,024,768
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Endowment Spending as Percent of Ending Endowment Value

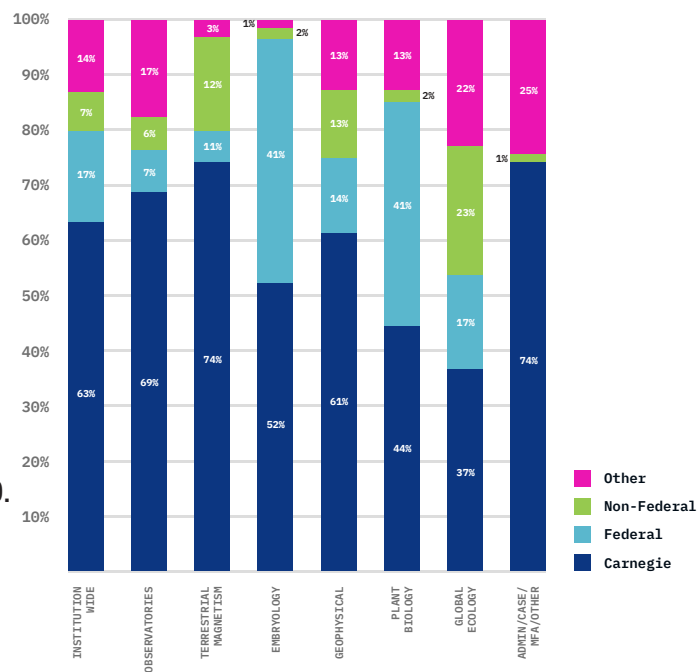


year-end endowment value, multiplied by the spending rate of 5% and adjusted for inflation and debt. This method reduces volatility from year-to-year. The following figure depicts actual spending as a percentage of ending market value for the last 20 years.

In fiscal year 2020, Carnegie benefitted from continuing federal support. Carnegie received \$16.5 million in new/additional federal grants in 2020. This is a testament to the high quality of Carnegie scientists and their ability to compete successfully for federal funds.

Within Carnegie’s endowment, there are several “funds” that provide support either in a general way or targeted to a specific purpose. The largest of these is the Andrew Carnegie Fund, begun with the original gift of \$10 million. Mr. Carnegie later made additional gifts totaling another \$12 million during his lifetime. This tradition of generous support for Carnegie’s scientific mission has continued throughout our history and a complete list of donors in fiscal year 2020 can be found in the online annual report at www.carnegiescience.edu/annual-report/2020. In addition, Carnegie receives important private grants for specific research purposes.

Expenses by Funding Type by Department



FORMER PRESIDENTS

Daniel C. Gilman, 1902–1904
Robert S. Woodward, 1904–1920
John C. Merriam, 1921–1938
Vannevar Bush, 1939–1955
Caryl P. Haskins, 1956–1971

Philip H. Abelson, 1971–1978
James D. Ebert, 1978–1987
Edward E. David, Jr.
(Acting President, 1987–1988)
Maxine F. Singer, 1988–2002

Michael E. Gellert,
(Acting President, January–April 2003)
Richard A. Meserve, 2003–2014
Matthew P. Scott, 2014–2017

FORMER TRUSTEES

Philip H. Abelson, 1978–2004
Alexander Agassiz, 1904–1905
Robert O. Anderson, 1976–1983
Lord Ashby of Brandon, 1967–1974
J. Paul Austin, 1976–1978
George G. Baldwin, 1925–1927
Thomas Barbour, 1934–1946
Daniel N. Belin, 2000–2009
James F. Bell, 1935–1961
John S. Billings, 1902–1913
Robert Woods Bliss, 1936–1962
Samuel W. Bodman, 2009–2013
Amory H. Bradford, 1959–1972
Lindsay Bradford, 1940–1958
Omar N. Bradley, 1948–1969
Lewis M. Branscomb, 1973–1990
Michael Brin, 2006–2009
Robert S. Brookings, 1910–1929
James E. Burke, 1989–1993
Vannevar Bush, 1958–1971
John L. Cadwalader, 1903–1914
William W. Campbell, 1929–1938
John J. Carty, 1916–1932
Whitefoord R. Cole, 1925–1934
John T. Connor, 1975–1980
Tom Cori, 1999–2010
Edward E. David, Jr., 1960–2017
Frederic A. Delano, 1927–1949
John Diebold, 1975–2005
Cleveland H. Dodge, 1903–1923
William E. Dodge, 1902–1903
William T. Coleman, Jr., 1997–2017
James D. Ebert, 1987–2001
Gerald M. Edelman, 1980–1987
Charles P. Fenner, 1914–1924
Michael Ference, Jr., 1968–1980
Homer L. Ferguson, 1927–1952
Simon Flexner, 1910–1914
W. Cameron Forbes, 1920–1955
James Forrestal, 1948–1949
William N. Frew, 1902–1915
Lyman J. Gage, 1902–1912
William K. Gayden, 2002–2019
Walter S. Gifford, 1931–1966
Carl J. Gilbert, 1962–1983
Cass Gilbert, 1924–1934
Frederick H. Gillett, 1924–1935
Daniel C. Gilman, 1902–1908
Robert G. Goelet, 1980–2014
William T. Golden, 1969–2007
Hanna H. Gray, 1974–1978
Crawford H. Greenewalt, 1952–1984
David Greenewalt, 1992–2003

William C. Greenough, 1975–1989
Patrick E. Haggerty, 1974–1975
Caryl P. Haskins, 1949–1956, 1971–2001
John Hay, 1902–1905
William R. Hearst III, 1992–2017
Richard Heckert, 1980–2010
Barklie McKee Henry, 1949–1966
Myron T. Herrick, 1915–1929
Abram S. Hewitt, 1902–1903
William R. Hewlett, 1971–2001
Henry L. Higginson, 1902–1919
Ethan A. Hitchcock, 1902–1909
Henry Hitchcock, 1902
Herbert Hoover, 1920–1949
William Wirt Howe, 1903–1909
Freeman A. Hrabowski III, 2002–2004
Charles L. Hutchinson, 1902–1904
Walter Isaacson, 2015–2018
Walter A. Jessup, 1938–1944
Frank B. Jewett, 1933–1949
George F. Jewett, Jr., 1983–1987
Antonia Ax:son Johnson, 1980–1994
William F. Kieschnick, 1985–1991
Samuel P. Langley, 1904–1906
Kenneth G. Langone, 1993–1994
Ernest O. Lawrence, 1944–1958
Charles A. Lindbergh, 1934–1939
William Lindsay, 1902–1909
Henry Cabot Lodge, 1914–1924
Alfred L. Loomis, 1934–1973
Robert A. Lovett, 1948–1971
Seth Low, 1902–1916
Wayne MacVeagh, 1902–1907
William McChesney Martin, 1967–1983
Keith S. McHugh, 1950–1974
Steven L. McKnight, 2000–2014
Burton J. McMurtry, 1996–2004
Jaylee Mead, 1999–2008
Andrew W. Mellon, 1924–1937
John C. Merriam, 1921–1938
J. Irwin Miller, 1988–1991
Margaret Carnegie Miller, 1955–1967
Roswell Miller, 1933–1955
Darius O. Mills, 1902–1909
S. Weir Mitchell, 1902–1914
Andrew J. Montague, 1907–1935
Henry S. Morgan, 1936–1978
William W. Morrow, 1902–1929
Seeley G. Mudd, 1940–1968
Franklin D. Murphy, 1978–1985
William I. Myers, 1948–1976
Garrison Norton, 1960–1974
Paul F. Orefice, 1988–1993

William Church Osborn, 1927–1934
Walter H. Page, 1971–1979
James Parmelee, 1917–1931
William Barclay Parsons, 1907–1932
Stewart Paton, 1916–1942
Robert M. Pennoyer, 1968–1989
George W. Pepper, 1914–1919
Richard S. Perkins, 1959–2000
John J. Pershing, 1930–1943
Henning W. Prentis, Jr., 1942–1959
Henry S. Pritchett, 1906–1936
Gordon S. Rentschler, 1946–1948
Sally K. Ride, 1989–1994
David Rockefeller, 1952–1956
Elihu Root, 1902–1937
Elihu Root, Jr., 1937–1967
Julius Rosenwald, 1929–1931
William M. Roth, 1968–1979
William W. Rubey, 1962–1974
Martin A. Ryerson, 1908–1928
Howard A. Schneiderman, 1988–1990
Robert C. Seamans, 1974–2008
Henry R. Shepley, 1937–1962
Theobald Smith, 1914–1934
John C. Spooner, 1902–1907
Frank Stanton, 1963–2006
William Benson Storey, 1924–1939
Richard P. Strong, 1934–1948
Charles P. Taft, 1936–1975
William H. Taft, 1906–1915
William S. Thayer, 1929–1932
Charles H. Townes, 1965–1998
Juan T. Trippe, 1944–1981
William I.M. Turner, Jr., 1990–2015
Hatim A. Tyabji, 2002–2004
James W. Wadsworth, 1932–1952
Charles D. Walcott, 1902–1927
Frederic C. Walcott, 1931–1948
Henry P. Walcott, 1910–1924
Lewis H. Weed, 1935–1952
Sidney J. Weinberg, Jr., 1983–2010
William H. Welch, 1906–1934
Gunnar Wessman, 1984–1987
Andrew D. White, 1902–1916
Edward D. White, 1902–1903
Henry White, 1913–1927
James N. White, 1956–1979
George W. Wickersham, 1909–1936
Robert E. Wilson, 1953–1964
Robert S. Woodward, 1905–1924
Carroll D. Wright, 1902–1908

A gift for the future

One of the most effective ways to support the work of Carnegie Science is to include the institution in your estate plans. By doing so, you can support cutting-edge, independent scientific research well into the future.

Leaving a gift to Carnegie Science in your will, by bequest or beneficiary designation, can honor the values you hold most dear. You may also generate significant tax savings for your estate. You can designate your gift to support staff positions and fellowships, specific research projects, or other programs and can be endowed in perpetuity. For more information, please contact the Office of Advancement at 202-939-1145.



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